KMA350 / KME300
Computational, Numerical Methods 3

Introduction.

These subjects will be taught by Prof Larry Forbes in 2013. These are both 12.5% units, and there are 3 lectures per week on the computational and numerical methods content. (Students in **KME300** also get 9 lectures on basic ordinary and partial differential equations, and these occur as one lecture per week over 9 weeks. Science students are welcome to sit in on this extra section). There is also one tutorial per week, with a computer lab session. There are no tutorials in the first week, and we will sort out which tutorial group you are in, during that first week.

Numerical methods are necessary in science and engineering, because most problems of practical interest are just too difficult to be solved in "closed form". While many important problems, such as the motion of a mass on a spring *etc.*, have "exact" solutions in terms of known functions such as sin or cos, these are nevertheless "simple" problems. Making these problems just a little more complicated leads very quickly to equations that have no easy solutions. Numerical techniques are therefore needed.

Often the approach that is needed to solve a problem numerically is quite unlike the way that you would solve the same problem by hand (eigenvalues are a good example of this). In addition, the numerical solution of some problems can have its own behaviour, which may not be an accurate reflection of the behaviour of the true solution. For that reason, it is important to keep a check on how accurate a method is, and whether it converges (in some sense) to the true solution.

This unit gives an introduction to using numerical methods to solve some of the key problems in science and engineering. We first consider how computers represent numbers and functions, and then consider how to solve algebraic equations. A problem of major importance in engineering science concerns the solution of linear (matrix) equations. Eigenvalues of a matrix are very important in applications, since they tell us the vibrational frequencies of a structure for example, and we will consider how to calculate the eigenvalues of a matrix. Approximate methods for integrating and differentiating functions will be discussed. Finally, we will have a brief introduction to the problem of solving differential equations using the computer.

In the 9 lectures on differential equations, we will look at the basic (linear, second-order) differential equations that arise in simple mechanical devices and electrical circuits. We will look at the simplest (exponential) methods for solving these ODEs exactly, and there will also be a short section on using Laplace Transforms to solve ODEs. Finally, we will look at the three classical second-order partial differential equations (PDEs) from engineering mathematics – the heat equation, Laplace's equation and the wave equation – and how to solve them using separation of variables.

Lectures.

Monday	11 am	Physics Lecture Theatre 2	KME300 required
Tuesday	10am	Physics Lecture Theatre 1*	All students (room change)
Wednesday	1pm	Chemistry Lecture Room 210	All students
Thursday	2pm	Physics Lecture Theatre 1	All students

Tutorials.

There will be "practicals" (tutes) in the computer labs 254 and 329 in the Physics building. Details will be sorted out in Week 1. (The timetable only lists them as KME300, but they are available to everyone). The tutes will consist of the usual problem-solving sessions, but will also make use of the numerical package *MATLAB* , which has become an industry standard in many engineering and scientific applications. It's a useful skill for you to become familiar with what *MATLAB* can do, since there's a reasonable chance you'll be using it (or something a lot like it) in your professional lives.

Reference text and reading list.

The Reference Text for this unit is: *Advanced Engineering Mathematics*, 9th edition, E. Kreyszig (Wiley 2006). This is an excellent reference book to have on the shelf (after you've finished University!), and if you can afford it, is well worth having.

There are lots of books on the market that give a reasonable introduction to Numerical Methods, and many are more detailed than Kreyszig. Some useful reading books are:
Elementary Numerical Analysis, K. Atkinson (Wiley 1985)
Numerical Analysis, 4th edition, R.L. Burden and J.D. Faires (PWS-Kent 1989)
Numerical Methods Using MATLAB, 4th ed., J.H. Mathews and K.D. Fink (Pearson 2004)

There are many books with the title "Numerical Analysis" or something similar, and these ought to be helpful, too.
The book by Kreyszig also has a reasonable reference section on differential equations.

Assessment.

The assessment will consist of fortnightly assignments (I expect there will be six), and a two-hour final examination. Each assignment will have a *MATLAB* component. The final grade for the unit will be made up from:

Assignments	20%
Final Exam	80%

For **KME300** students, the ODE and PDE component will count for 25% of the total mark for this unit.

I may put the assignments and some extra programmes on my homepage at the address
http://www.maths.utas.edu.au/People/Forbes/Classes.html
Hopefully, that material will also be available through the new MyLo system.